The Convergence of the Smart Grid with Photovoltaics:
Identifying Value and Opportunities

California Public Utilities Commission

Smart Grid Rulemaking

R.08-12-009

Workshop 2 — The Distribution System

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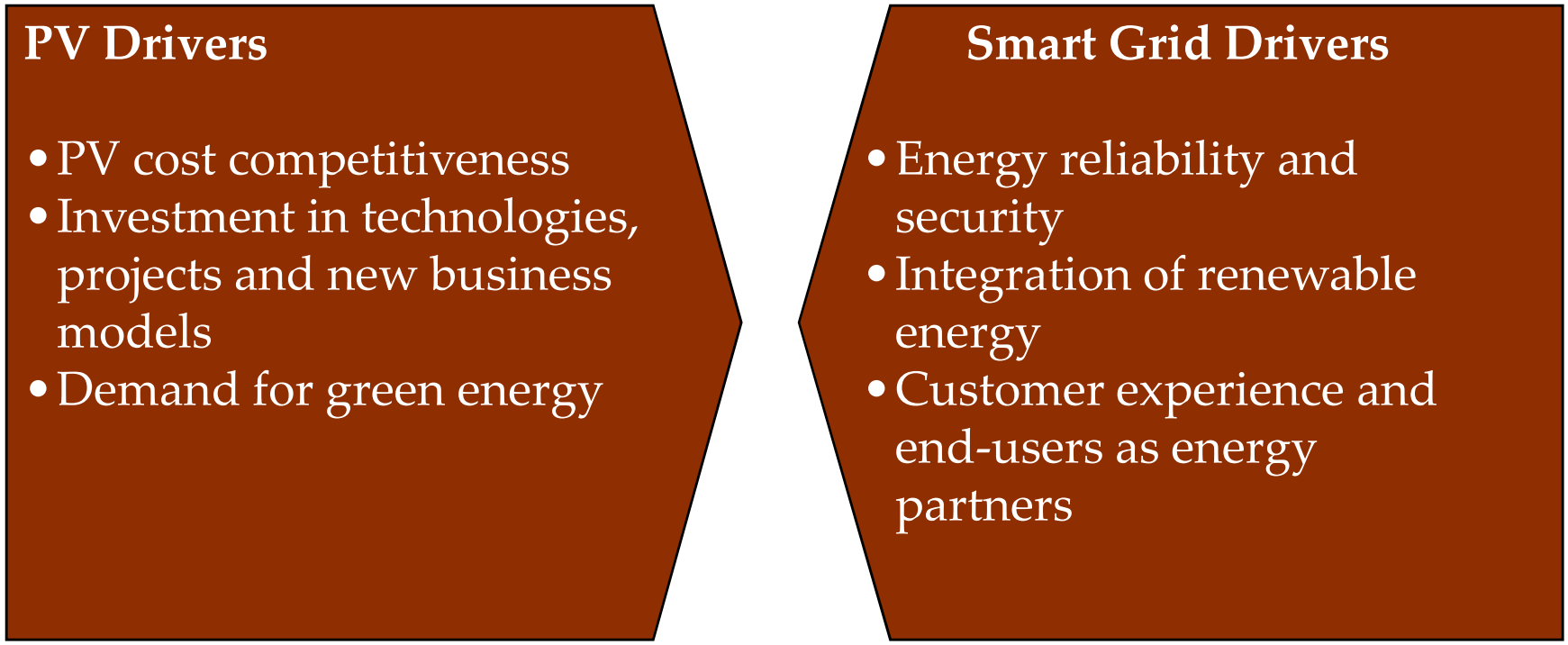
Situation

While the PV market has entered a time of robust growth, electric utilities and others have begun to implement the Smart Grid.



Navigant Consulting did a large multi-client study to examine the value and opportunities created by integrating PV with Smart Grid.

For public version of the study: http://www.navigantconsulting.com/downloads/knowledge_center/SmartGridPVMulti-Client_US_EG.pdf

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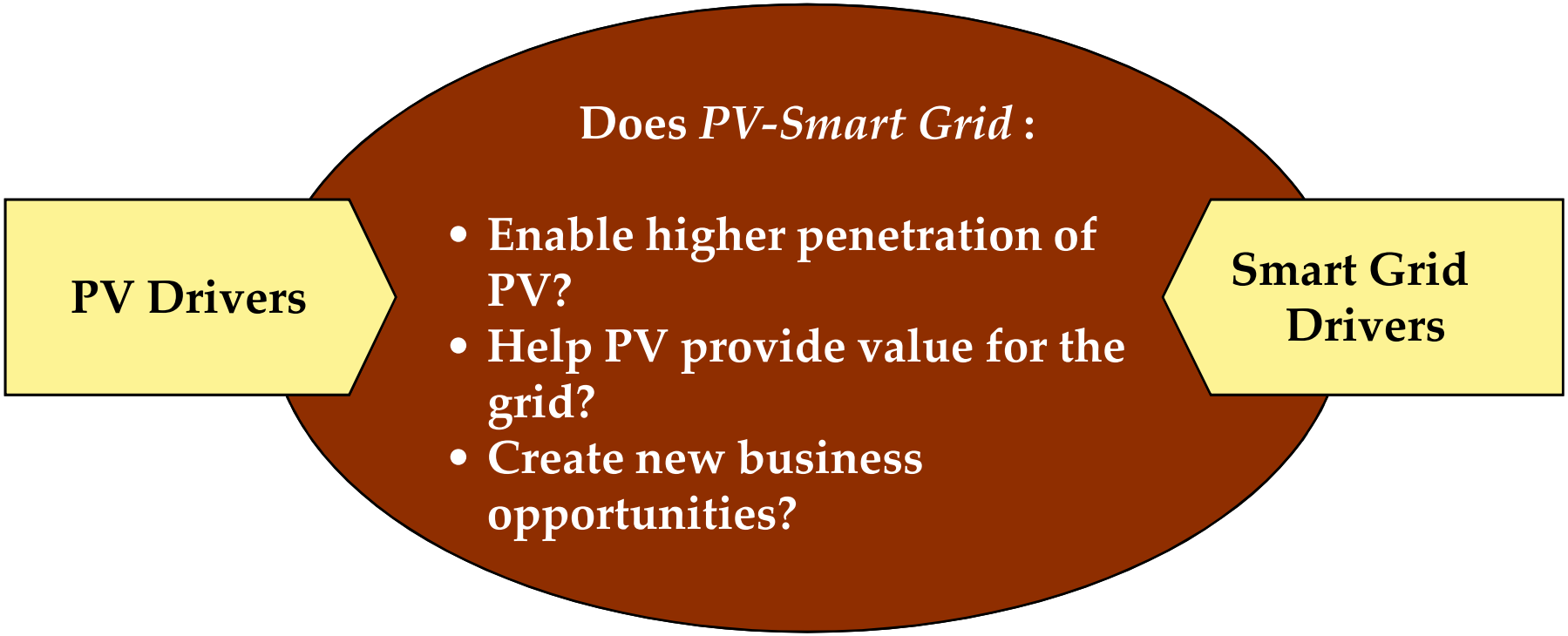
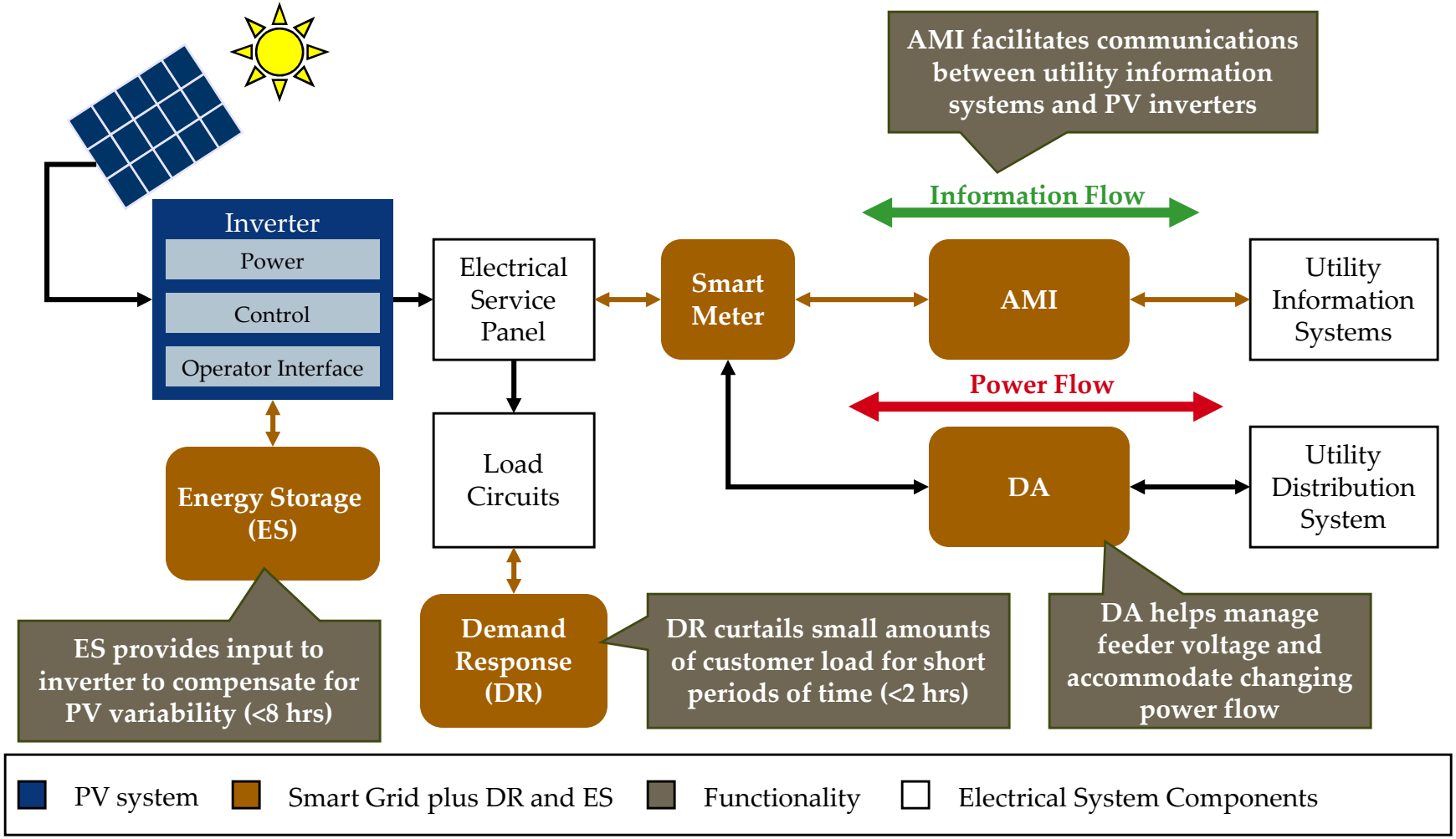
Opportunity

The *PV-Smart Grid* may present an opportunity to address key issues faced by PV and Smart Grid alone.



Smart Grid-PV Framework

Smart Grid systems support better communications and control between distributed resources and the utility distribution system.



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Smart Grid Enables More PV on Distribution Feeders

The Smart Grid enables higher penetrations of PV by addressing key technical challenges.

Can the PV-Smart Grid enable higher penetrations of PV?

- Barriers to high penetration of PV include:
  - Technical T&D challenges
  - Communications challenges
  - Regulatory and business model challenges
- The Smart Grid addresses key technical T&D challenges
- By addressing the technical issues will allow utilities to accept more PV on distribution feeders without compromising operating performance and service quality

Yes. Smart Grid could support more PV on distribution feeders.

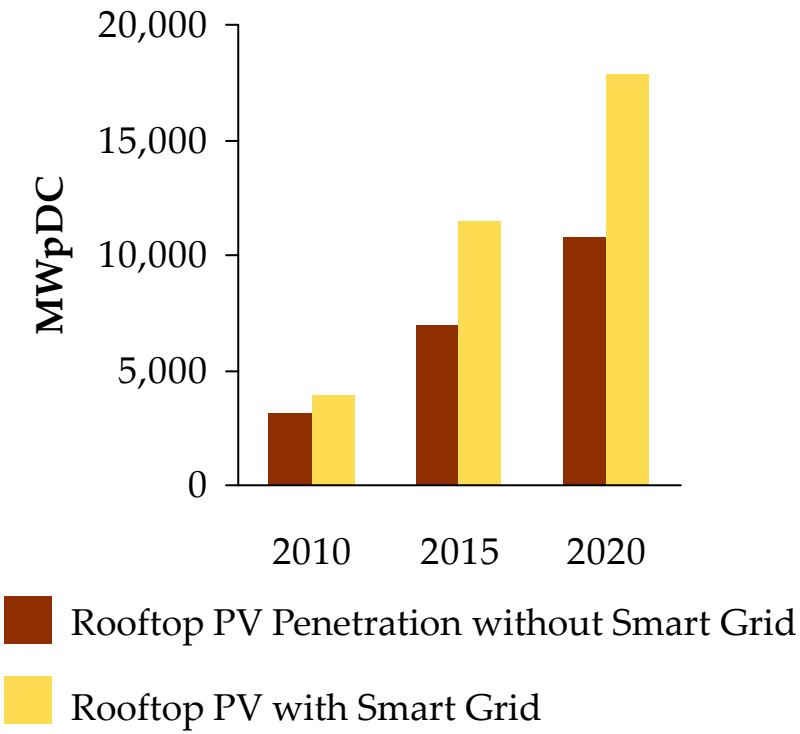
Increased Distributed PV Penetration

NCI estimates that rooftop PV penetration could be significantly higher by 2020 as a result of addressing T&D barriers with Smart Grid.

The Smart Grid Enables Higher Penetration of PV

- The Smart Grid coupled with energy storage can address important T&D challenges:
  1. Voltage Regulation
  2. Reverse Power Flow
  3. Power Fluctuations/Frequency Regulation
- Addressing these challenges supports higher net metering caps, better interconnection standards and more prevalent time of use tariffs options
- These changes simplify interconnection of PV and improve its economics, increasing the projected installed capacity by over 60% by 2020.

Cumulative Installed Capacity Rooftop PV



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High Penetrations of PV Adds New Value

Distributed PV can provide benefits in key areas. Combining this resource with energy storage enhances its value.

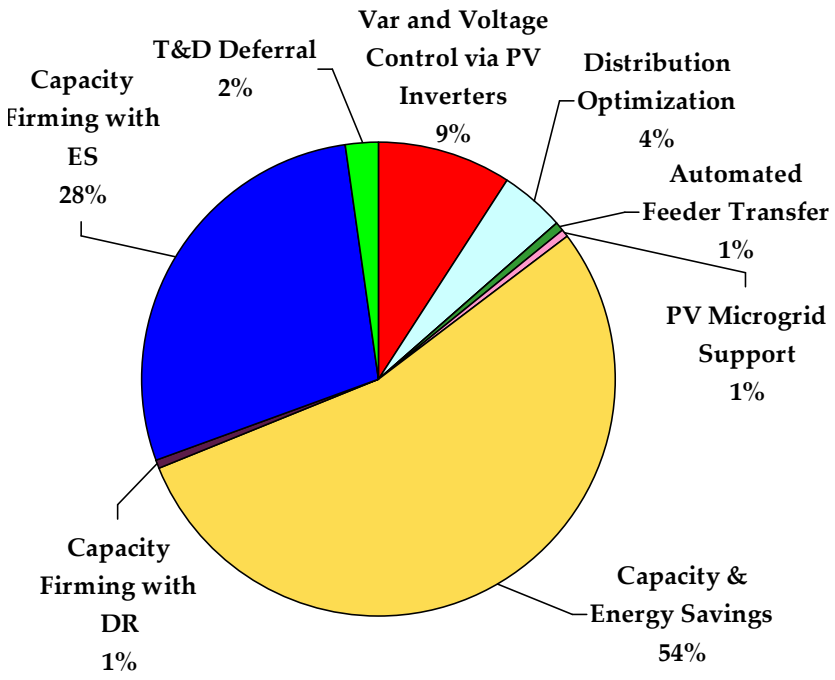
Can the PV-Smart Grid help PV provide value for the grid?

- The greatest value of PV is derived from avoiding central generating capacity and avoided energy costs
- Energy storage is a key for enhancing the value of PV in a Smart Grid context
- When concentrated, PV can provide benefits related to grid optimization
- PV is cost effective assuming continuation of rebates and ITC credits – however, the incremental value of Smart Grid is not enough to overcome the loss of incentives

Yes. PV in high penetrations can provide grid benefits.

Areas of Value Creation

Analysis shows that PV provides value from capacity and energy savings, firmer capacity with energy storage, and grid optimization.



- Capacity and energy savings
- Firmer capacity with energy storage
- Grid optimization

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Unlocking Value Could Create New Business Opportunities

By leveraging the Smart Grid and high penetrations of distributed PV, new opportunities to unlock value can be created.

Can the PV-Smart Grid create new business opportunities?

- The analysis reveals three main areas for new value:
  - Deferred/avoided energy and capacity from traditional generation
  - Smart capacity firming by combining PV with energy storage
  - Grid optimization through coordinated control of PV inverters
- Tapping this value will require enhancements to technology, policy and business models

Yes. PV-Smart Grid could create new business opportunities.

Enhancements to Achieve Benefits

Achieving the benefits highlighted in the study requires enhancement of technology, policy and business models.

Technology

- Technical/business requirements for coordination of AMI and PV
- Functional requirements for leveraging PV as a grid resource

Policy

- Eligibility of integrated PV/energy storage systems for state/federal rebates and Investment Tax Credits
- Modification of technical standards (e.g., IEEE 1547) to allow PV inverters to provide grid support

Business Models

- Tariffs and pricing mechanisms that monetize the benefits provided by distributed PV
- Service offerings to facilitate participation of PV as a grid resource

Summary Answers to Key Questions

The PV Smart Grid will create additional value, primarily by enabling increased PV penetration on the distribution grid.

Does the PV-Smart Grid create value? *Yes*

Does the Smart Grid enable higher penetration of PV? *Yes*

- Challenges for high penetration of PV include: 1. T&D technical, 2. communications and 3. regulatory/business models
- Coupled with energy storage, the Smart Grid (AMI and DA) can address important T&D challenges: Voltage Regulation, Reverse Power Flow, and Power Fluctuations (Frequency Regulation)
- By addressing these challenges Smart Grid infrastructure could result in higher net metering caps, better interconnection standards and more prevalent time of use tariffs options. These changes could increase PV market penetration by over 60% by 2020

Does the Smart Grid help PV provide grid benefits? *Yes*

- PV-Smart Grid could result in several billion in additional benefits by 2020, depending on use of energy storage.
- Most of the additional benefits come from energy savings associated with high penetrations of PV, and the firming of capacity that can be achieved with integrated energy storage
- A smaller share of additional benefits can be classified as "grid benefits", and are created by the coordinated control of high penetrations of PV, especially when it is concentrated in specific pockets

Does the PV-Smart Grid create Business Opportunities? *Yes*

- PV Smart Grid has a benefit-cost ratio greater than 1.0
- The most promising opportunities resulting from the PV Smart Grid are:
  - –*DG PV Power Plant*, which could be implemented in the near term (3-5 years)
  - –*Smart Capacity Firming*, likely to unfold in medium term (5-10 years), unless energy storage breakthrough earlier.
  - –*Distribution Optimization*, requires broad implementation of Smart Grid; Likely to unfold in medium term (5-10 years), given complexity

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For a full copy of the public release of *"The Convergence of the SmartGrid with Photovoltaics: Identifying Value and Opportunities"*
Please visit NCI's Knowledge Center:
http://www.navigantconsulting.com/downloads/knowledge_center/SmartGridPVMulti-Client_US_EG.pdf

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